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INVENTORY OF FOREST AND RANGELAND AND DETECTION OF FOREST STRESS

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16. Abstract Seventy-two ground sensors were interfaced with three DCP's at our Black Hills test site. Unfortunately, the transmitters had to be returned to General Electric for modification so that we do not have forestry sensed data available. The DCP's did operate properly from our Berkeley laboratory and data were recovered from the Goldstone and Alaska stations via Goddard.

Replicated training sets and test sets have been selected from all three test site areas in preparation for the receipt of ERTS imagery and digital tapes. From 600 to 800 points have been selected at each site location and UTM coordinates determined. Templates are being made of these sets.

As of September 1, we have not received any ERTS-generated data and cannot make any statements regarding quality or suitability for our forest and range experiments.

Aerial photography (scale 1:32,000) of the Manitou (226C) and Black Hills (226A) sites was taken with CIR in June. Various scales (1:2,000; 1:10,000; 1:20,000; and 1:40,000) of 70 mm photographs were obtained at Manitou with normal color, CIR, and panchromatic in August.

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Figure 2. Technical Report Standard Title Page

TITLE: Inventory of Forest and Rangeland and Detection of Forest Stress

ERTS Proposal Number 226

Black Hills Test Site (Forest Stress) 226A

Coinvestigator: Frederick P. Weber

GSFC Identification Number AG-014

Principal Investigator - Robert C. Heller

STATEMENT OF PROBLEMS:

1. Insufficient lead time between receipt of funding and the launch of ERTS-A has been a problem. We had estimated five months of prelaunch activity for purchase and fabrication of equipment, with sufficient time allotted for identifying and eliminating problems. We actually had six weeks for these tasks, and it was just not enough time.

2. Our data collection platforms failed (2 of 3) during the first few hours of operation due to a design deficiency in the program board assembly. Although we were able to perform the fault analysis on the field test set and identify the problem, no replacement program cards were available. As a result, we have lost three weeks of test site ground data.

3. No money has been allocated for the processing and analysis of MSS data collected in the Black Hills in May 1972 by the University of Michigan C-47 aircraft. These MSS data were to serve as an important information base and must be processed soon.

4. We were promised a test data set from the MSS and RBV subsystems for debugging our digital classification routines. The very late date of arrival of the data--within 10 days of satellite launch--somewhat handicapped our ability to effectively deal with "live" data.

5. We have received no ERTS image data for the Black Hills, although to date there have been three passes over the site.

ACCOMPLISHMENTS DURING THE REPORTING PERIOD:

1. Early in the period all equipment and materials required for the establishment of the DCS/DCP experiment in the Black Hills were ordered. As components arrived, they were added to the system so that by satellite launch time (July 23, 1972) the data acquisition and transmitting subsystems were 80 percent completed.

2. A data packing system was built to multiplex three data bits into each DCP channel. This gives a current capability to monitor data from 72 instruments rather than just 24 as would normally be done with three operating DCP's. Operating on a 90-second duty cycle, we have been able to transmit nine data sets from each DCP during a satellite pass. This provides for three complete cycles through the multiplex sequence.

3. Our existing Digital - Data Acquisition System (Vidar 5304 D-DAS) was interfaced with the DCP's subsystem to provide a parallel data recording capability for checking on the reliability of the DCS. It was felt important to have a parity check which would reveal problems as they develop as a result of data passing through the entire communications network.

4. As planned, five 4-channel ERTS-matched spectrometers were built and tested in our laboratory in Berkeley. Calibration data taken prior to their installation in the Black Hills indicated they are as good or better than had been expected in terms of calibration stability and detector responsivity. A small field modification was made to change the field of view from 3 degrees to 15 degrees to facilitate a larger area of target response integration.

5. Following a checkout of the DCP/D-DAS system at our Berkeley laboratory during the first week of the ERTS flight, the entire system was moved to the Black Hills test site for installation. Sensor installation and hookup to the communication and recording system were completed in August on the four planned Black Hills ecosystem subsites: (1) healthy ponderosa pine, (2) bark beetle-attacked and stressed ponderosa pine, (3) rangeland pasture, and (4) soil and rock outcrop sites. A specially constructed 60-foot antenna tower was built at the test site so as to place the DCP antennas above the forest canopy. Very low-loss coaxial cable was installed (0.7 dp/100') from the DCP's to the antennas.

6. Aerial photography taken in May at a scale of 1:33,500 by the Forest Service Aero Commander equipped with a Zeiss RMK 21/23 camera has been used as the primary source of information for selecting training samples and test sets. Prior to acquiring the current photography, a combination of older photos, available maps, and personal knowledge was used to pinpoint likely training sets. To date, 800+ points in the Black Hills have been located and interpreted as the data base for future interpretation analysis. Data points are well distributed geographically throughout the Black Hills with a minimum of 50 observations cataloged for each of eight of the ecosystem subcategories. These include data on healthy pine, pine under stress, natural and cultivated pasture and rangeland, water storage areas, soil and rock outcrops and urban areas.

Although consideration will be given to all subcategories for the total area classification, major attention will be given to the identification and location of stress trees--particularly bark beetle infestations--within the ponderosa pine community.

WORK PLANNED FOR NEXT REPORTING PERIOD:

1. Acquisition of aerial color infrared photography of 11 townships in the northern Black Hills, which includes the major current stress problem areas, is planned for early September. This additional 1:33,500 scale photography will be used to update the ground truth data about the existence and size of current stress areas, principally bark beetle infestations. These infestations change in size and location for each generation of beetles.

2. We plan to exercise the first full-scale analysis of data returned through the DCP/DCS system. Specifically, we hope to point out differences in the data communicated through the DCS as compared with the on-site recorded data.

3. Hopefully, we can begin multispectral processing on the first Black Hills MSS digital tapes. This will include both in-house digital processing and contracted hybrid processing.

4. Data collected by the C-130 24-channel scanner will be previewed and a detailed multispectral data processing plan developed.

SIGNIFICANT RESULTS:

1. At Mr. Earl Painter's (GSFC) request, we installed our three DCP's on the roof of the Berkeley Experiment Station to test the accuracy of relaying ground sensor data from ERTS to the Goldstone, California, and Alaska ground stations. Two DCP's transmitted simulated forestry data on July 23--the date of the ERTS launch. The third began transmissions on Tuesday, July 25. Continuous transmissions were made until Thursday, July 27 when two DCP's failed. Television station KRON (NBC), San Francisco, showed movies of the setup on the Tuesday night news at 8:30 p.m., July 25, 1972. Printouts of the relayed data received from Goddard were correct in all respects.

PUBLICATIONS: None

RECOMMENDATIONS FOR CHANGES: None

STANDING ORDER FORM CHANGES: None

ERTS IMAGE DESCRIPTOR FORMS: None, no ERTS imagery available

DATA REQUEST FORM CHANGES: None submitted

TITLE: Inventory of Forest and Rangeland and Detection of Forest Stress

ERTS Proposal Number 226

Atlanta Test Site (Forest Inventory) 226B

Coinvestigator: Robert C. Aldrich

GSFC Identification Number AG-014

Principal Investigator - Robert C. Heller

STATEMENT OF PROBLEMS:

1. Lack of sufficient Forest Service funding and the lateness of our NASA proposal financing resulted in our being six to eight weeks behind schedule in our prelaunch and postlaunch activities. One computer programmer and one research technician were not hired, and one vacancy has not been filled--due to lack of funds. Essential equipment needed in prelaunch preparations could not be ordered in time to be useful. This resulted in our using less efficient techniques.

2. We have received no ERTS data for the Atlanta test site.

3. Aircraft support data flown in early June by MSC (RB-57 Mission 205) have not been received. The time lag of 10 weeks has resulted in a large backlog of image interpretation during the preparation stages for ERTS image analysis.

ACCOMPLISHMENTS DURING THE REPORTING PERIOD:

1. Photo interpreters examined over 11,000 systematically located points on 1:60,000 scale IR color photographs. The photographs were supplied by Earth Observations Aircraft Program Mission 191 (November 1971). Each point was classified into one of eight land use classes: (1) pine, (2) upland hardwood, (3) bottomland hardwood, (4) agriculture, (5) pasture, (6) transitional agriculture, (7) water, and (8) urban and other. In addition, the area involved in each land use at the point was estimated and placed in one of six resolution cell sizes: (1) less than 100 meters, (2) 100 meters, (3) 200 meters, (4) 300 meters, (5) 400 meters, and (6) 500 meters. The results of the interpretation are shown below:

Land Class	Resolution Cell Size (meters) <100	100	200	300	400	500	Total	Percent of Area
	Number of points							
Pine	2827	694	174	35	7	3	3740	34.4
Upland hardwood	2232	531	163	47	12	21	3006	27.6
Bottomland hardwood	333	108	31	5	6	1	484	4.4
Agriculture	623	159	27	3	0	1	813	7.5
Pasture	580	233	66	8	6	1	894	8.2
Transitional	401	59	11	1	1	0	473	4.3
Water	102	12	1	0	0	0	115	1.1
Urban and other	760	178	116	75	51	177	1357	12.5
Total	7858	1974	589	174	83	204	10,882[1]	100.0

[1] 126 points fell in disturbed forest land, and 437 points could not be classified.

2. One-hundred points over 100 meters in size were systematically selected from each land use classification. Fifty will be used to train photo interpreters on multiband photographs and color composites. These same points, identified by their UTM coordinates, will be used to train a large computer to identify the spectral characteristics of each land use class on ERTS multispectral scanner tapes. The second set of 50 points will be used as a test set to determine the levels of accuracy obtainable by photo interpreters and various computer classification techniques.

3. A random sample of 20 points was picked from each of the forest and agricultural training sets. These 120 points will be examined on the ground at the time of each ERTS supporting aircraft mission. Eighty of these points were examined between June 19 and 29, 1972 (following RB-57 Mission 205). Tree species, type, site, and ground cover descriptions were recorded for each forest point. Crop types and idle, abandoned, and pasture vegetative conditions were recorded for each agricultural point. Both an IR color and normal color photo were taken of each point to record conditions at the time of the examination.

4. Following the ground examination, all 851 points were reexamined by an experienced interpreter. Using the information gained from the ground checks, photo interpretation was corrected where necessary. The number of points in each class was then adjusted to result in 50 points in both the training and test set data.

5. Point locations were transferred to 3-time enlargements of sections of the 1:250,000 scale topographic map made on stable base photographic material. Each map section was made to include at least four UTM grid coordinate intersections. Each of the 1:60,000 IR color transparencies was placed, in turn, in an Elwood enlarger and reduced to the scale of the enlarged map section (1:83,000). By matching photo details with map details, precise scaling could be accomplished and each point accurately transferred from the photo to the map. A minimum of two porminent road, stream, or power line intersections was plotted for each photo setup.

6. Base maps were made on stable material to show 10,000-meter easterly and 10,000-meter northerly UTM coordinate intersections. The maps were constructed to the scale of the enlarged map sections to facilitate transferring point locations by matching UTM coordinates. Each point was pinpricked and numbered.

7. The base maps were photographed with a precision copy camera. The negatives will be used to produce transparent overlays for use in photo interpretation as soon as ERTS data become available.

8. Computer programs are in preparation to use with ERTS four-channel multispectral scanner data. RBV data will also be used if available. Several of the data analysis techniques developed for microdensitometer data are being modified to use with MSS data. These include both supervised and unsupervised techniques.

WORK PLANNED FOR NEXT REPORTING PERIOD:

1. Transparent overlays will be made from the training and test set base map negatives. These overlays will be scaled to use with: (1) an I^2S Additive Color Viewer and the four bands of MSS imagery, (2) a projector viewer and individual bands of MSS imagery, and (3) composite 9- x 9-inch imagery from the MSS.

2. Depending on the receipt of ERTS data, we will train interpreters to identify eight land use classes using the three interpretation devices outlined above. Interpretation of the test set data will follow.

3. Two men will spend 10 days (October 5-15) gathering ground data in connection with an RB-57 aircraft support mission and an expected ERTS overpass on October 14 and 15.

4. When received, data from aircraft support Mission 205 (June 1972) will be annotated for filing. All 851 data points for the ERTS experiment will be transferred to the new imagery and reinterpreted.

5. Computer programming will be continued. It is hoped that an additional programmer can be hired in the near future to speed up this part of the experiment. As ERTS data become available, we will begin tests with available computer programs.

SIGNIFICANT RESULTS: None

PUBLICATIONS: None

RECOMMENDATIONS FOR CHANGES: None at present

STANDING ORDER FORM CHANGES: None

ERTS IMAGE DESCRIPTOR FORMS: None

DATA REQUEST FORM CHANGES: None submitted

TITLE: Inventory of Forest and Rangeland and Detection of Forest Stress

ERTS Proposal Number 226

Manitou Test Site (Rangeland Inventory) 226C

Coinvestigator: Richard S. Driscoll

GSFC Identification Number AG-014

Principal Investigator - Robert C. Heller

STATEMENT OF PROBLEMS:

1. Aerial imagery collected by NASA WB-57F on June 14-15, 1972, has not been received.

2. No ERTS-A imagery or tapes have been received from the data passes over the Manitou site on August 1-2, 1972, and August 19-20, 1972.

3. Multiscale and multispectral 70 mm imagery taken by the Forest Service Aero Commander on August 11-12, 1972, has not been received. Lack of imagery to work with has prevented our making progress on this experiment.

ACCOMPLISHMENTS DURING THE REPORTING PERIOD:

1. Primary effort for our ERTS-A experiment was initiated in January 1972 and consisted of data searches for vegetation maps and aerial photographs of NASA Test Site 242 included in ERTS Project 226. Forest type maps were obtained from the Forest Service Regional Office in Denver; no grassland or shrubland vegetation maps were available except for very gross vegetation classes. Complete aerial photography coverage of the total area was also not available. Consequently, we flew the total area during June 7-9, 1972, for complete aerial photo coverage at a scale of approximately 1:28,000 with the Forest Service Aero Commander equipped with the Zeiss RMK 21/23 camera.

2. The maps and photos were used to develop a vegetation and land use classification system. This now consists of seven forest types, two shrub types, eight grassland types for natural vegetation classes, and four nonvegetation classes including water empondments, small towns, new subdivision developments, and nonvegetated rockland.

3. To date, 576 training sets for computer analysis have been selected for the forest types, 22 for the shrublands, and 63 for nonvegetation. All training sets are referenced to the UTM coordinate system of land survey. Since all data were selected from maps and aerial photos, a 10 percent sample of these training sets was selected for field validation. Each sample area has been visited on the ground, and data about plant species cover, abundance, and distribution and the physiography of the site have been obtained.

4. For the grassland types, 60 sample training sets have been subjectively selected on the ground and keyed to UTM. Since we have no previous data, these areas will be used for computer training for classification, and later validation, of the grassland classes.

5. Intensive ground truth was obtained at Manitou proper during the first three weeks in August. This included multispectral radiance data of individual plant species and mixtures, ground cover by species, and biomass productivity of four different grassland classes. These data are to be related by correlation and regression to multispectral high-flight aircraft and the ERTS-A imagery.

6. The total Manitou test site was overflown by the NASA WB-57F aircraft on June 14 and 15, 1972.

7. Two data passes by the ERTS-A satellite have occurred--August 1-2, 1972, and August 19-20, 1972.

8. The Forest Service Aero Commander was used to obtain multiscale multispectral photography of our intensive site on August 11-12, 1972.

WORK PLANNED FOR NEXT REPORTING PERIOD:

1. Three detailed data analysis plans will be completed:

a. Microdensitometry for analysis of ERTS-A and supporting aircraft data.

b. Human interpretation of ERTS-A and supporting aircraft data.

c. Multistage sampling with ERTS-A and supporting aircraft data.

Other detailed plans, including analysis by optical combining and direct EDP are pending receipt of the ERTS-A data.

2. Training set validation will be completed for the forest, shrubland, and nonvegetation classes. Other training set samples will be selected for the grassland classes.

3. Preliminary "first-look" analyses will be made of the ERTS-A and aircraft data as soon as they are received.

SIGNIFICANT RESULTS: None to report because no ERTS-A data have been received to date.

PUBLICATIONS: None released

RECOMMENDATIONS FOR CHANGES: None at present

STANDING ORDER FORM CHANGES: None

ERTS IMAGE DESCRIPTOR FORMS: None; no ERTS imagery available.

DATA REQUEST FORM CHANGES: None submitted